Gulf of Alaska Octopus

Council staff discussion paper for GOA Plan Team review
September 2013

1 Introduction

In June 2013, the Council moved to request a discussion paper for consideration at its October 2013 meeting regarding the potential for a directed octopus fishery in the Gulf of Alaska (GOA). Per this request information is assembled below in order to best inform the Council of the available stock assessment and management information as well as the process by which the Council could consider recommending a directed octopus fishery in the GOA. The Council will receive the GOA Plan Team comments in October and take further action at that time as needed.

2 Stock assessment overview

At least seven species of octopus are found in the GOA. While the species composition of the natural community and the commercial harvest are not well documented, research indicates that the Giant Pacificf octopus *Enteroctopus dofleini* is the most abundant species in shelf waters and comprises the majority of the catch in commercial fisheries (Conners et al., 2012). Octopus are currently grouped into a single assemblage and managed as a complex.

2.1 Life History and Stock Structure

The following section has been excerpted from the 2012 GOA Octopus stock assessment (Conners et al., 2012)"

> In general, octopuses are fast growing with a life span generally less than 5 years. Life histories of seven of the eight species in the Gulf of Alaska are largely unknown. *Enteroctopus dofleini* has been studied extensively in Alaskan, Japanese and Canadian waters and its life history will be reviewed here; generalities on the life histories of the other seven species will be inferred from what is known about other members of the genus.
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> *Enteroctopus dofleini* within the Gulf of Alaska have been found to mature between 10 to 20 kg with 50% maturity values of 13.7 kg (95% CI 12.5-15.5 kg) for females and 14.5 kg (95% CI = 12.5-16.3 kg) for males(Conrath and Conners, in press). *Enteroctopus dofleini* are problematic to age due to soft chalky statoliths (Robinson and Hartwick 1986). Therefore the determination of age at maturity is difficult for this species. In Japan this species is estimated to mature at 1.5 to 3 years and at similar but smaller size ranges (Kanamaru and Yamashita 1967, Mottet 1975).

Within the Gulf of Alaska this species has a protracted reproductive cycle with a peak in spawning in the winter to early spring months. Due to differences in the timing of peak gonad development between males and females it is likely that females have the capability to store sperm. This phenomenon has been documented in an aquarium study of octopus in Alaska (Jared Gutheridge pers com) and British Columbia (Gabe 1975). Fecundity for this species ranges from 40,000 to 240,000 eggs per female with an average fecundity of 106,800 eggs per female. Fecundity is significantly and positively related to the size of the female. The fecundity of *E. dofleini* within this region is higher than that reported for other regions. The fecundity of this species in Japanese waters has been estimated at 30,000 to 100,000 eggs per female (Kanamaru 1964, Mottet 1975, Sato 1996). Gabe (1975) estimated a female in captivity in British Columbia laid 35,000 eggs. Hatchlings are approximately 3.5 mm. Mottet (1975) estimated survival to 6 mm at 4% while survival to 10 mm was estimated to be 1%; mortality at the 1 to 2 year stage is also estimated to be high (Hartwick, 1983). Since the highest mortality occurs during the larval stage, it is probable that ocean conditions have a large impact on numbers of *E. dofleini* in the GOA and large fluctuations in numbers of *E. dofleini* should be expected.

Enteroctopus dofleini is found throughout the northern Pacific Ocean from northern Japanese waters, throughout the Aleutian Islands, the Bering Sea and the Gulf of Alaska and as far south down the Pacific coast as southern California (Kubodera, 1991).The stock structure and phylogenetic relationships of this species throughout its range have not been well studied. Three sub-species have been identified based on large geographic ranges and morphological characteristics including *E. dofleini dofleini* (far western North Pacific), *E. dofleini apollyon* (waters near Japan, Bering Sea, Gulf of Alaska), and *E. dofleini martini* (eastern part of their range, Pickford 1964). A recent genetic study (Toussaint et al. 2012) indicate the presence of a cryptic species of *E. dofleini* in Prince William Sound, Alaska and raises questions about the stock structure of this species. There is little information available about the migration and movements of this species in Alaska waters. Kanamaru (1964) proposed that *E. dofleini* move to deeper waters to mate during July through October and then move to shallower waters to spawn during October through January in waters off of the coast of Hokkaido, Japan. Studies of movement in British Columbia (Hartwick et al. 1984) and south central Alaska (Scheel and Bisson 2012) found no evidence of a seasonal or directed migration for this species, but longer term tagging studies may be necessary to obtain a complete understanding of the migratory patterns of this species. Additional genetic and/or tagging studies are needed to clarify the stock structure of this species in Alaska waters.

Octopus californicusis a medium-sized octopus with a maximum total length of approximately 40 cm. Very little is known about this species of octopus. It is collected between 100 to 1,000 m depth in Alaska and has been reported in even deeper waters off the coast of California (Smith and Mackenzie 1948). It is believed to spawn 100 to 500 eggs. Hatchlings are likely benthic; hatchling size is unknown. The female likely broods the eggs and dies after hatching.

Octopus rubescens has been reported from Prince William Sound in the central GOA, but has not been verified in survey collections. *Octopus rubescens* appears to have a two year life cycle with egg laying occurring in July through September and hatching occurring 5 to 10 months later in February through March. Females of this species are terminal spawners estimated to lay approximately 3,000 eggs (Dorsey 1976). *Octopus rubescens* has a planktonic larval stage.

Octopus sp. A is a small-sized species with a maximum total length < 10 cm. This species has only recently been identified in the GOA and its full taxonomy has not been determined. *Octopussp. A* is likely a terminal spawner with a life-span of 12 to 18 months. The eggs of *Octopussp. A* are likely much larger than those of *O. rubescens*, as they appear to have larger

benthic larvae. Females of *Octopus sp. A* lay between 80 to 90 eggs that take up to six months or more to hatch.

Benthoctopus leioderma is a medium sized species; its maximum total length is approximately 60 cm. Its life span is unknown. It occurs from 250 to 1400 m and is found throughout the shelf break region. It is a common octopus and often occurs in the same areas where *E. dofleini* are found. The eggs are brooded by the female but mating and spawning times are unknown. Members of this genus in the North Pacific Ocean have been found to attach their eggs to hard substrate under rock ledges and crevices(Voight and Grehan 2000). *Benthoctopus* tend to have small numbers of eggs (<200) that develop into benthic hatchlings.

Opisthoteuthis californiana is a cirrate octopus; it has fins and cirri (on the arms). It is common in the GOA but is not likely to be confused with *E. dofleini*. It is found from 300 to 1,100 m and is likely common over the abyssal plain. *Opisthoteuthis californiana* in the northwestern Bering Sea have been found to have a protracted spawning period with multiple small batch spawning events. Potential fecundity of this species was found to range from 1,200 to 2,400 oocytes (Laptikhovsky 1999). There is evidence that *Opisthoteuthis species* in the Atlantic undergo 'continuous spawning' with a single, extended period of egg maturation and a protracted period of spawning (Villanueva 1992). Other details of its life history remain unknown.

Japetella diaphana is a small pelagic octopus. Little is known about members of this family. In Hawaiian waters gravid females are found near 1,000 m depth and brooding females near 800 m depth. Hatchlings have been observed to be about 3 mm mantle length (Young 2008). This is not a common octopus in the GOA and not likely to be confused with *E. dofleini*.

Vampyroteuthis infernalisis a cirrate octopus. It is not common in the GOA and is easily distinguishable from other species of octopus by its black coloration. Very little is known about its reproduction or early life history. An 8 mm ML hatchling with yolk was captured near the Hawaiian Islands indicating an egg size of around 8 mm for this species (Young and Vecchione 1999).

In summary, there are at least seven species of octopus present in the GOA, and the species composition both of natural communities and commercial harvest is unknown. At depths less than 200 meters, *E. dofleini* appears to have the highest biomass, but the abundances of *Octopussp. A* and *B. leioderma* are also very high. The greatest difference in species composition between the Bering Sea Aleutian Islands (BSAI) and the GOA is the presence of *O. californicus* and the small *Octopus sp. A*.

The GOA trawl surveys produce estimates of biomass for octopus, but these estimates are highly variable and may not reflect the same size octopus caught by industry (Connors et al., 2012). Octopus are taken in trawl, longline and pot fisheries in the GOA with the highest catch rates from the Pacific cod pot fisheries in the central and western GOA. A portion of the catch is retained or sold for human consumption or bait.

Data are currently insufficient to support a model-based assessment for GOA octopus. The SSC has determined that GOA octopus are in Tier 6 due to inadequate data to reliably estimate biological parameters for Tier 5. There are no historical records of directed fishing for octopus, thus catch estimates are for incidental catch in groundfish fisheries (Connors et al., 2012). This complicates the ability to set an average catch-based OFL and ABC. A modified Tier 6 approach has been considered using the maximum incidental catch from 1997-2006 to set the OFL with ABC = 75% of the OFL. However since 2010 the GOA PT and the SSC have recommended using an average of the last three survey biomass estimates and applying a Tier 5 calculation to obtain an OFL. This modified Tier 6 approach includes a

conservative estimate of natural mortality of 0.53 and a minimum biomass estimate using the average of the last three surveys. Using a Tier 5-like calculation of OFL, average minimum B×M (3,662 t × 0.53 = 1,941 t) and the ABC equal to 0.75 × OFL (1,455 t) is estimated. This approach recognizes that the catch history is not appropriate for Tier 6 management and that the biomass estimates and M estimates are not sufficient for a Tier 5 approach. The OFL and ABC for the complex have been managed gulf-wide.

The stock assessment author currently does not recommend a directed fishery without further information being available on an appropriate index for octopus. However the author has indicated that a small experimental fishery which would provide more biological information and further develop octopus-specific index survey gear could be useful.

3 Catch and in-season management

3.1 Incidental catch information

Catch specifications and catch in recent years are shown below. As noted the incidental catch is primarily in the Pacific cod pot fisheries in the western and central GOA.

Year	OFL	ABC	TAC	Catch
2011	1,272	954	954	917
2012	1.941	1,455	1,455	421
2013 (through 9/3)	1,941	1,455	1,455	196

In 2012 23% of the catch was discarded while in 2013 to date 56% has been discarded. Discard mortality rate estimation analyses are underway by the stock assessment author but are not currently employed in management thus mortality is assumed to be 100% for purposes of accrual against the TAC.

Table 2 (below) from the 2012 stock assessment indicates the relative incidental catch by year and target fishery (Conners et al., 2012) while Table 3 shows the relative catch by region in the GOA.

Table 2. Estimated state and federal catch (t) of all octopus species combined, by target fishery. Catch for 1997-2002 estimated from blend data. Catch for 2003-2012 data from AK region catch accounting Due to updates and corrections in the catch accounting system, numbers for 2003-2010 differ slightly from previous assessments. *Data for 2012 are as of October 6, 2012; catch figures for flatfish targets have been revised to include the IFQ Halibut fishery.

	Target Fishery						
Year	Pacific cod	Pollock	Flatfish*	Rockfish	Sablefish	Other	Total
1997	193.8	0.7	1.3	2.3	22.4		232
1998	99.7	3.5	4.3	0.8	0.3		112
1999	163.2	0.0	2.4	0.5	0.2		166
2000	153.5	-	0.7	0.2	0.5		156
2001	72.1	0.2	0.8	0.0	2.0		88
2002	265.4	0.0	17.2	0.7	1.0		298
2003	188.9	-	16.6	0.6	2.9	0.1	210
2004	249.8	0.0	2.8	0.4	0.1	16.5	270
2005	138.6	0.1	2.4	0.2	0.2	1.7	149
2006	151.0	3.4	1.9	0.5	0.3	0.2	166
2007	242.0	1.5	9.7	0.1	1.8	-	257
2008	326.0	0.0	5.2	2.9	0.2	0.1	339
2009	296.8	0.1	10.1	1.2	0.3	0.9	310
2010	263.7	0.8	15.4	3.7	0.5	41.9	326
2011	859.4	2.3	49.9	0.9	0.8	1.1	918
2012*	272.4	0.0	3.5	0.9	0.8	-	278

Table 2. Catch by region for octopus complex 2003-2012

	Estimated Catch for Octopus Complex (t)									
Region	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
East	3.7	0.7	0.0	0.5	0.2	0.2	0.5	0.0	3.0	0.2
Central	61.4	81.6	91.4	128.0	192.9	213.0	168.7	185.2	351.7	150.1
West	144.5	187.3	58.0	37.5	64.3	125.5	140.4	141.2	563.0	127.8
All GOA	209.7	269.6	149.4	166.0	257.4	338.7	309.6	326.4	917.7	278.0

3.2 State waters catch

State fisheries exist in Cook Inlet and Prince William Sound. GHLs established for these areas are as follows: Cook Inlet is GHL 35,000 lb (15.3 t); Prince William Sound GHL is a range from 0-35,000 lb (15.3 t).

3.3 In-season management issues

Currently octopus is managed under a gulfwide TAC and on bycatch-only status. Should the Council recommend (and NMFS approve) opening a directed fishery for octopus in the upcoming specifications cycle, the following process would need to occur beginning with initial specifications in October:

1. GOA Plan Team recommends area-specific ABC break-outs for preliminary specifications to the SSC for purposes of the proposed rule. This would indicate to the public that the final specifications (to be specified in December) would include ABC and TAC by area.
2. The November Octopus stock assessment would need to include options for establishing ABC by area to be recommended by the GOA PT.
3. SSC recommends area-specific ABCs in December. Council sets ABC and TAC by area. These catch limits would not be effective until February/March absent NMFS revising the final 2013/14 harvest specifications for January 1, 2014. Thus opening a directed fishery would not occur until the 2014/15 harvest specifications are approved.
4. For catch accounting and fish tickets there is only one species code, 870. At least seven species are found in the GOA. The species composition both of the natural community and the commercial harvest is not well documented, but research indicates that the Giant Pacific octopus, *Enteroctopus dofleini*, is the most abundant octopus species in shelf waters and makes up the bulk of octopus catches in commercial fisheries. We may want to have a separate species code for Giant Pacific octopus. This is a regulatory amendment (proposed and final rulemaking) for Table 2a FMP Species Codes and a Catch Accounting System programming change.
5. Species identification guides for industry (vessel and plant operators) may be needed. This would depend on how difficult octopus are to identify. Guides for rockfish and skates have been provided previously. As an alternative, retention of smaller octopus could be prohibited to limit harvest to *E. dofleini* (other species do not grow as large).
6. No change would be necessary to Maximum retainable amounts Table 10. If octopus is open for directed fishing then retained octopus can be used as a basis species even though the species in the "other species" group are not open for directed fishing. However, if it was decided that octopuses needed to be separate from "other species" in Table 10 then it is a regulatory amendment (proposed and final rulemaking).
7. An assessment would need to be made if an octopus directed fishery would increase incidental catch of groundfish or other PSC species.
8. An assessment of gear specifications may be needed. Octopus habitat pots are generally longlined, which is prohibited for crab pots. It is also possible to fish octopus with trawls and tangle hooks, or by scuba diving. Some kind of gear specifications would probably be needed.

4 Discussion items for GOA Plan Team

The main discussion items for the plan team are as follows:

1. Should the Council decide to open a directed fishery, how best should area apportionments be made?
2. What are the pros and cons of opening a directed fishery (conservation concerns compared with potentially increased data collection)? Are there any management recommendations that could accompany a potential directed fishery that would allay conservation concerns?
3. How difficult are octopus to identify to species, is a species identification guide needed?
4. Should a minimum size limit be used for retained octopus.
5. What gear should be allowed?
6. What is the potential for increased incidental catch of groundfish and PSC species?
7. Other concerns?

Plan team discussion and recommendations will be reflected in the GOA PT report.

5 References

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